

I CLAIM:

1. A method of encoding a video stream, the method comprising the steps of:

receiving the video stream;

5 generating a base bitstream comprising one or more base video object planes (VOPs) using the video stream, each base VOP being associated with a base presentation time stamp (PTS) and a base decoding time stamp (DTS); and

10 generating a first enhancement bitstream comprising one or more first enhancement VOPs using the video stream, each first enhancement VOP being associated with a corresponding base VOP, a first DTS and a first PTS,

15 wherein the first DTS and the first PTS associated with each first enhancement VOP are selected to be equal to one another, the first PTS associated with each first enhancement VOP is selected to be equal to the base PTS associated with its corresponding base VOP, and the first DTS associated with each first enhancement VOP is
20 selected to be equal to the base DTS associated with one of the base VOPs.

2. The method of encoding the video stream according to claim 1, the method further comprising the step of
25 generating a second enhancement bitstream comprising one or more second enhancement VOPs using the video stream, wherein each second enhancement VOP is associated with two corresponding base VOPs, a second DTS and a second PTS, and wherein the second DTS and the second PTS associated with
30 each second enhancement VOP are selected to be equal to one another.

3. The method of encoding the video stream according to claim 2, wherein the first DTS is selected to be different from any of the second DTSs.

5 4. The method of encoding the video stream according to claim 3, wherein the second DTS associated with each second enhancement VOP represents an interval that is right after the later of the two intervals represented by the two base DTSs associated with its two corresponding base VOPs.

10 5. The method of encoding the video stream according to claim 1, wherein the encoding comprises MPEG-4 encoding.

15 6. The method of encoding the video stream according to claim 2, wherein the encoding comprises fine granularity scalability (FGS) encoding.

20 7. The method of encoding the video stream according to claim 6, wherein the first enhancement bitstream comprises FGS bitstream and the first enhancement VOPs comprise FGS VOPs.

25 8. The method of encoding the video stream according to claim 7, wherein the second enhancement bitstream comprises FGS temporal scalability (FGST) bitstream and the second enhancement VOPs comprise FGST VOPs.

30 9. The method of encoding the video stream according to claim 2, the method further comprising the step of combining the first and second enhancement bitstreams to generate a single enhancement bitstream.

10. The method of encoding the video stream according to claim 1, the method further comprising the steps of packetizing the base bitstream and the first enhancement bitstream, and multiplexing the packetized bitstreams to
5 generate a transport stream.

11. A method of decoding a multiplexed bitstream to generate a video stream, the method comprising the steps of:

10 receiving the multiplexed bitstream;
demultiplexing and depacketizing the multiplexed bitstream to generate a base bitstream and a first enhancement bitstream;
decoding the base bitstream to generate one or
15 more base video object planes (VOPs), each base VOP being associated with a base presentation time stamp (PTS) and a base decoding time stamp (DTS);
decoding the first enhancement bitstream to generate one or more first enhancement VOPs, each first
20 enhancement VOP being associated with a corresponding base VOP, a first DTS and a first PTS; and
presenting the first enhancement VOPs and the base VOPs to be displayed,
wherein each first enhancement VOP is decoded and
25 presented at the same time unit, and wherein each first enhancement VOP and its corresponding base VOP are presented at the same time unit.

12. The method of decoding the multiplexed bitstream
30 according to claim 11, wherein the demultiplexing and depacketizing step further generates a second enhancement bitstream, method further comprising the step of decoding

the second enhancement bitstream to generate one or more second enhancement VOPs, wherein each second enhancement VOP is associated with two corresponding base VOPs, a second DTS and a second PTS, and wherein each second enhancement VOP is decoded and presented at the same time unit.

13. The method of decoding the multiplexed bitstream according to claim 12, wherein each second enhancement VOP is decoded right after the second of the two corresponding base VOPs has been decoded, unless this would cause the second enhancement VOPs to be decoded out of display order, in which case, the second enhancement VOPs are decoded in the display order.

14. The method of decoding the multiplexed bitstream according to claim 11 wherein the decoding comprises MPEG-4 decoding.

15. The method of decoding the multiplexed bitstream according to claim 12, wherein the decoding comprises fine granularity scalability (FGS) decoding.

16. The method of decoding the multiplexed bitstream according to claim 15, wherein the first enhancement bitstream comprises FGS bitstream and the first enhancement VOPs comprise FGS VOPs.

17. The method of decoding the multiplexed bitstream according to claim 16, wherein the second enhancement bitstream comprises FGS temporal scalability (FGST)

bitstream and the second enhancement VOPs comprise FGST VOPs.

18. The method of decoding the multiplexed bitstream
5 according to claim 11, wherein the multiplexed bitstream is an MPEG-4 Transport stream.

19. A video encoding system for generating a base
bitstream and one or more enhancement bitstreams using a
10 video stream, the video encoding system comprising:

a base encoder for receiving the video stream and
for generating the base bitstream using the video stream,
the base bitstream comprising one or more base video object
planes (VOPs);

15 an enhancement encoder for receiving processed
video data from the base encoder and for generating a first
enhancement bitstream using the processed video data, the
first enhancement bitstream comprising one or more first
enhancement VOPs, each first enhancement VOP being
20 associated with a corresponding base VOP; and

a multiplexer for time stamping each base VOP
with a base decoding time stamp (DTS) and a base
presentation time stamp (PTS), for time stamping each first
enhancement VOP with a first DTS and a first PTS, for
25 packetizing the base bitstream and the first enhancement
bitstream into packets, and for multiplexing the packets to
generate a multiplexed bitstream,

wherein the first DTS and the first PTS
associated with each first enhancement VOP are selected to
30 be equal to one another, the first PTS associated with each
first enhancement VOP is selected to be equal to the base
PTS associated with its corresponding base VOP, and the

first DTS associated with each first enhancement VOP is selected to be equal to the base DTS associated with one of the base VOPs.

5 20. The video encoding system according to claim 19, wherein the enhancement encoder generates a second enhancement bitstream using the processed video data, the second enhancement bitstream comprises one or more second enhancement VOPs, and each second enhancement VOP is
10 associated with two corresponding base VOPs,

 wherein the multiplexer time stamps each second enhancement VOP with a second DTS and a second PTS, packetizes the second enhancement bitstream into second packets, and multiplexes the second packets with the
15 packets for the base bitstream and the first enhancement bitstream to generate the multiplexed bitstream, and

 wherein the second DTS and the second PTS associated with each second enhancement VOP are selected to be equal to one another.
20

 21. The video encoding system according to claim 20, wherein the first DTS is selected to be different from any of the second DTSs.

25 22. The video encoding system according to claim 21, wherein the second DTS associated with each second enhancement VOP represents an interval that is right after the later of the two intervals represented by the two base DTSs associated with its two corresponding base VOPs.
30

23. The video encoding system according to claim 19, wherein the encoding comprises MPEG-4 encoding, and the multiplexed bitstream is an MPEG-4 Transport stream.

5 24. The video encoding system according to claim 20, wherein the encoding comprises fine granularity scalability (FGS) encoding.

10 25. The video encoding system according to claim 24, wherein the first enhancement bitstream comprises FGS bitstream and the first enhancement VOPs comprise FGS VOPs.

15 26. The video encoding system according to claim 25, wherein the second enhancement bitstream comprises FGS temporal scalability (FGST) bitstream and the second enhancement VOPs comprise FGST VOPs.

20 27. The video encoding system according to claim 20, wherein the first and second enhancement bitstreams are combined to generate a single enhancement bitstream.

28. The video encoding system according to claim 19, wherein each VOP comprise a plurality of bit planes.

25 29. The video encoding system according to claim 19, wherein the base encoder performs discrete cosine transform (DCT) on the video stream to generate DCT coefficients, and wherein the DCT coefficients are provided as the processed video data to the enhancement encoder.

30

30. A video decoding system for generating a base layer video and an enhancement video using a multiplexed bitstream, the video decoding system comprising:

a demultiplexer for demultiplexing and
5 depacketizing the multiplexed bitstream to generate a base bitstream and a first enhancement bitstream;

a base decoder for decoding the base bitstream to generate one or more base video object planes (VOPs), each base VOP being associated with a base presentation time
10 stamp (PTS) and a base decoding time stamp (DTS); and

an enhancement decoder for decoding the first enhancement bitstream to generate one or more first enhancement VOPs, each first enhancement VOP being associated with a corresponding base VOP, a first DTS and a
15 first PTS,

wherein each first enhancement VOP is decoded and presented at the same time unit, and wherein each first enhancement VOP and its corresponding base VOP are presented at the same time unit.

20

31. The video decoding system according to claim 30, wherein the demultiplexer generates a second enhancement bitstream, and the enhancement decoder decodes the second enhancement bitstream to generate one or more second enhancement VOPs, and wherein each second enhancement VOP
25 is associated with two corresponding base VOPs, a second DTS and a second PTS, and wherein each second enhancement VOP is decoded and presented at the same time unit.

30 32. The video decoding system according to claim 31, wherein each second enhancement VOP is decoded right after the second of the two corresponding base VOPs has been

decoded, unless this would cause the second enhancement VOPs to be decoded out of display order, in which case, the second enhancement VOPs are decoded in the display order.

5 33. The video decoding system according to claim 31 wherein the base decoder comprises one or more frame buffers for storing partially decoded base bitstream and the enhancement decoder comprises one or more frame buffers for storing partially decoded second enhancement bitstream,
10 wherein not more than a total of three frame buffers are used at a time for decoding and presenting all of the base bitstream and the first and second enhancement bitstreams.

15 34. The video decoding system according to claim 30 wherein the decoding comprises MPEG-4 decoding.

20 35. The video decoding system according to claim 31, wherein the decoding comprises fine granularity scalability (FGS) decoding.

25 36. The video decoding system according to claim 35, wherein the first enhancement bitstream comprises FGS bitstream and the first enhancement VOPs comprise FGS VOPs.

30 37. The video decoding system according to claim 36, wherein the second enhancement bitstream comprises FGS temporal scalability (FGST) bitstream and the second enhancement VOPs comprise FGST VOPs.

35 38. The video decoding system according to claim 30, wherein the multiplexed bitstream is an MPEG-4 Transport stream.